

4.0 V&V STATUS AND USAGE HISTORY

This portion of ASP-I summarizes applications the model has been used to support, and the extent to which those applications have been supported by V&V documentation. Information on prior accreditations of the model is also provided in the paragraphs below.

4.1 V&V STATUS

Internal V&V

The perspective of the intelligence community on validation, verification, and accreditation of digital models and simulations is important to this assessment effort, and is outlined in a White Paper authored by Betsy Witt of the NAIC Aerodynamic Weapons Design Branch [8]. The paper states that “NAIC subscribes to the Military Operations Research Society’s (MORS) definitions of verification, validation, and accreditation”, and is the key to understanding how the simulation was developed, how it is maintained and upgraded, and how it is verified and validated at NAIC.

The TRAP code is constantly updated by the NAIC modelers with Scientific and Technical Intelligence (S&TI) and Foreign Material Exploitation (FME) data. The Model Developer performs the final quality control checks on all changes to the core simulation and threat models. Engineering Design Change Memos [9] are filed at NAIC to document major code changes and the internal V&V efforts applied to them. These classified memos may be requested through NAIC/TANW. Table 4-1 lists the activities conducted at NAIC in support of TRAP V&V and points of contact for those efforts. Unfortunately, documentation is not available to specifically define these actions.

TABLE 4-1. NAIC Activities in Support of TRAP V&V.

Division	Type of Action	Point of Contact
Aerodynamic Weapon Design Branch (TANW)	Model comparisons	Betsy Witt (513) 257-2653
“	Hardware-in-the-loop (HITL) tests	“
“	Live fire tests (LFTs) - Aerodynamics	“
“	Definition of simulation	Lt. Ed Jenkins
“	Methods	Craig Logan
“	Valid conditions	“
“	Major improvements	“
“	Overall simulation performance	Joe Herrmann
Engagement Analysis Branch (TAAE)	TRAP inputs converted to TAC BRAWLER format; flyouts in both to ensure performance within acceptable tolerance.	Tim Kanoy (513) 257-2404
“	TRAP inputs converted to AASPEM format; flyouts in both to ensure performance within acceptable tolerance.	Scott Fullenkamp
“	Verify other models against TRAP	Mark Butler
TAAA	Comparisons against Trial Yockleton LFT data	Dave Drake

The following list describes the activities performed by TANW from the table above to support model V&V.

- Model-matches, HITL tests, LFT: Model data and outputs are compared against available intelligence available. Details and documentation associated with these validation efforts are classified.
- Definition of simulation: A simulation is considered by NAIC to be verified and validated when each of the components composing the simulation are integrated as a whole after being verified and validated separately.
- Methods: The methods used to implement individual components of the code are verified. The overall effect on simulation performance is examined.
- Valid conditions: Model limitations are examined to ensure that the simulation is applied under the correct conditions.
- Major improvements: When V&V efforts uncover deficiencies or new requirements are identified, code is developed and the model is improved. V&V assessments on new code are contained in Engineering Change Memos [9].
- Overall simulation performance: The overall performance of the simulation is examined. Missile kinematics (range, velocity, acceleration, delivered g's), launch zones, and equations of motion, state, dynamics, etc., are verified.

One invaluable source of FME data was the Trial Yockleton live firings of threat missiles by 'former' threat aircraft. Results of these trials are classified and on file at NAIC/TAAA, Wright-Patterson AFB, OH. Comparisons for validation purposes of TRAP model outputs to data obtained during hardware-in-the-loop evaluations were performed. Access to FME results may be obtained with the applicable clearance through Mr. Dave Drake, NAIC/TAAA.

Table 4-2 lists internally generated TRAP documentation with points of contact.

TABLE 4-2. NAIC TRAP Documentation.

Model	Agency	Point of Contact
Classified Documents, DIA Studies, Engineering Design Memos	NAIC/TANW	Joe Herrmann (513) 257-2653
Classified Documents	NAIC/TAAE	Mark Butler (513) 257-2404
SIMVAL Documents	NAIC/TANV	Mark Brunn (513) 257-3255

Other V&V Efforts

In 1992 following the first release of TRAP outside of NAIC, the Air Force Intelligence Support Agency (AFISA), now the 497th Intelligence Group, documented and accredited the software routines and model support infrastructure of the Version 3.0 library code. A copy of the classified report associated with this effort is on file in the SMART Project

Office [7]. Many of the findings apply to V.3.1 and 3.1a as well, due to similarities between versions. The following is a brief summary of that 1991 examination:

“Provides a high-fidelity simulation of missile aerodynamics;...could improve representation of non-symmetrical bank-to-turn missiles;...end-game computations do not model missile fuzing;...flyout computations adequate to determine missile kinematics during engagement;...adequate simulation for conventional (i.e., current) countermeasures;...cannot model random guidance errors possibly introduced by directed energy weapons.

Low-fidelity simulation of launch and target aircraft engagements adequate;...lacks advanced radar modeling for low-level look-down/shoot-down scenarios;...due to radar, may not provide accurate results for engagements involving reduced radar signature weapons systems;...does not model aircraft thrust vectoring, high angle-of-attack missile launch.

Recommend continued use of TRAP (3.0) for missile performance analysis of engagements that employ only conventional countermeasures;...larger model would enable more realistic engagements, especially low-level intercept;...requires modifications to air intercept radar, missile seeker (active),...and missile/aircraft aerodynamics (thrust vectoring capabilities and high-alpha maneuvers);...threat models of currently-deployed CIS missiles will provide realistic results using accepted engagement tactics.”

4.2 USAGE HISTORY

According to a survey sent to the user community to determine how the model was being used, TRAP has been used for a variety of analytical efforts, including assessment of threat capabilities, tactics development, procurement decisions, weapon system design, training system design, and combat training. The questionnaire is included in Appendix C. The first set of surveys were sent to 60 users in 58 different agencies as identified by SURVIAC on their list of users. Additional surveys were mailed to User’s Conference attendees and individuals who had contacted the model manager’s office with technical questions about TRAP. A third set of surveys were distributed to users identified by other users on return questionnaires. Both the SURVIAC list of users and a list of users identified by NAIC are contained in Appendix B. The major user of TRAP is the National Air Intelligence Center.

A total of 144 questionnaires were sent to 117 offices/agencies. Of the 50 users who had responded by November 1995, 41 had usable comments. Personal contact with each user contributed greatly to the response. Discussions were also held with some users as to equipment or software problems encountered in hosting and running the simulation. Table 4-3 lists the reported programs and projects that TRAP was used to support.

TABLE 4-3. Programs/Projects Supported by TRAP.

Program/Project	Description	User
Weapon system enhancements	Current and projected	McDonnell Douglas
TOP GUN/Navy Fighter Weapons School	Air-to-Air engagement philosophy and analysis	U.S. Navy/Marines
F-16	Weapon system derivations	Lockheed, Ft. Worth
AIM-9X	IR Air-to-Air Missile Upgrade	NAWCWPNS

TABLE 4-3. Programs/Projects Supported by TRAP. (Contd.)

Program/Project	Description	User
A-X Program	Navy Advanced Fighter	NAVY/NASC
F-22	Weapon system development, enhancements	Lockheed Ft. Worth & Lockheed Georgia
F-22	Full Mission Simulator	
Electronic Warfare	Lockheed Aero Systems	
F-22	IR Countermeasures (IRCM)	Lockheed Sanders, Inc.
CF-18 Study, CO-OP IRCM	IRCM	Lockheed Sanders Cmd Division
DIA Missile Modeling	Threat evaluations	DIA/NAIC
Missile Programs	Engineering design and performance assessments	NAIC/TANW
TRAP Dynamics Upgrade		Battelle, NAIC
MICOM/SSDC Radar Systems		MICOM
TAC BRAWLER vs. TRAP	Flyout comparisons	NAIC/TAAE
AASPEM vs. TRAP	Flyout comparisons	NAIC/TAAE
All AAM & ASM DIA Studies; UAVs; NAIC Bulletins; Alerts; Operational Customer QRIs; 497th Intell Group QRIs; AMRAAM; F-22; JAST; MCM 3-1, Vol I & II	Air-Air & Air-Surface Missiles DIA Threat Studies; Unmanned Air Vehicles; Quick Reaction Items; Advanced Medium Range AAM Threat Support; Joint Advanced Strike Technology; Multi-Command Tactics Manual	NAIC/TANW
Combat Effectiveness Studies McDonnell Douglas Flt Sim AGILE TRAP LAR Generation for Mission Planning	Flight Simulator Dogfight Air-to-Air Missile Launch Acceptability Regions	McDonnell Douglas
ARM Seeker Modeling	Anti-Radiation Missile Modeling	GTRI
Air Combat Simulator, Luke AFB	Analyze Missile Flyouts in Simulator	Martin Marietta Services, Inc./ACES

Others reported that they used TRAP as part of another model, or to compare output from another model against. Table 4-4 identifies other M&S that are, or have been used in conjunction with TRAP.

TABLE 4-4. TRAP Uses for Specific Applications.

Application	Description	Developer/User
J-MASS	Advanced EC Technique Analysis Workstation (AETAW)	Dynetics, Inc.
TEAM	Threat Engagement and Analysis Model	AFWIC/SAC
HOME	Homing Missile Engagement Model	AFWIC/SAC
F-22 FMS	Full Mission Simulator	Lockheed
DIME	Digital Integrated Modeling Environment	NAWCWPNS
MOSAIC	Modeling System for Advanced Investigation of Countermeasures	Science Applications International Corp. (SAIC)
JAST	Joint Attack Strike Technology	DoD
AASPEM	Air-to-Air System Performance Evaluation Model	NAIC/TAAE

TABLE 4-4. TRAP Uses for Specific Applications. (Contd.)

Application	Description	Developer/User
TACTS/ACTS	Tactical Aircrew Combat Training System/Air Combat Training System (Navy/AF)	FAAC, Inc.
RISS	Real-time Infrared Simulation System	Amherst, Inc.
TIAP	Threat Investigation and Analysis Program	Amherst, Inc.
ILECM	Improved Launch Envelope Calculation Methodology	Battelle USSTRACOM
IR STORM	Infrared Seeker Trade-Off Requirements	NAWCWPNS
IR STORM II	Infrared Seeker Trade-Off Requirements Model II	NAWCWPNS
TLAM	Tomahawk Land Attack Missile (Mission Planning Center Upgrade)	McDonnell Douglas
TIER II	Long endurance surveillance UAV for joint operations ("Predator")	Northrop/Grumman (General Atomics)
SPAM	Self-Protection Analysis Model	Georgia Tech Research Institute (GTRI)
TRAP/SPAM	Hybrid model of above	GTRI
MIRSAT	Missile Command (MICOM) Infrared Seeker Analysis Tool	U.S. Army MICOM
TACAWS	The Army Combined Arms Weapons System	U.S. Army
HAVV-TWO	Highly Agile Vehicle-Versus Two	ViGYAN, Inc. (NASA)
SEF-X	Single Engine Fighter-X (F-22 type)	ASC/XRED
MRF	Multi-Role Fighter Project	ASC/XRED

The F-22 System Program Office (SPO) uses TRAP heavily and is in the process of accrediting specific TRAP threat models. Their accreditation process is shown in Figure 4-1.

Recent developments have opened TRAP up to a new user community. In early February 1995, the Kick-Off Meeting for the Air-to-Air Missile Working Group (AAMWG) was held at the Air Force Electronic Warfare Evaluation Simulator (AFEWES), Ft. Worth, Texas. The mission of the AAMWG is to develop and maintain a common model repository of AAM flyout models for use in EC Hardware-in the Loop facilities, constructive simulations, and on OAR supporting the Operational Test & Evaluation (OT&E) community.

It was decided at the meeting that NAIC's TRAP simulation, with its close association to the intelligence community, would serve as the baseline model for use in these real-time applications. This recommendation was approved by DOT&E in March 1995, and is considered an accreditation of TRAP by the OT&E user community.

TRAP as it stands, however, must be modified to meet the real-time, hardware-to-software interface needs of the HITL and OAR test communities. A set of standards known as the Standard Interface for Missile Simulations (SIMS) has been developed which address the model taxonomy, model interface, coordinate systems, and sign conventions. Standardization reduces the possibility of test result inconsistencies when EW tests are conducted in multiple facilities and missile miss distances are used as a measure of effectiveness. It also allows software executives developed for a specific purpose to be used with more than one missile model library.

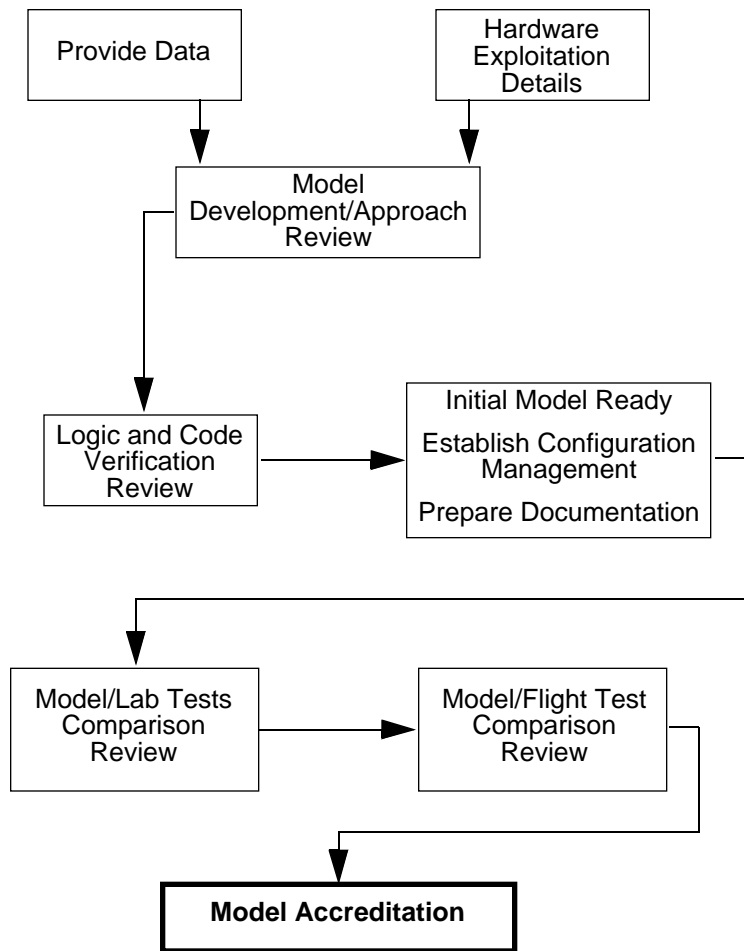


FIGURE 4-1. F-22 SPO Threat Model Accreditation Process.

Also in February of 1995, NAIC proposed to the JTCG/AS that the TRAP simulation be accepted as the “standardized” AAM Flyout Model Architecture and Interface [10]. The goal was to standardize AAM flyout modeling for ease of integration into hardware-in-the-loop and range simulations, and man-in-the-loop (MIL) dome simulations supporting the operations, intelligence, and acquisition communities. Although the FY96 project proposal was not funded, TRAP is in the SURVIAC library of codes and remains the defacto standard AAM for JTCG/AS.

User Descriptive, Change, and V&V Documentation

Several users indicated that their organizations had produced some type of descriptive, change, or V&V documentation on TRAP. A list of documents and organizations is shown in Table 4-5. Attempts to obtain these documents were unsuccessful. In many cases, proprietary information and classifications precluded the release of documentation. In some cases, users indicated that they had a high confidence that the simulation would perform as desired with user changes to fit their application.

TABLE 4-5. User Documentation.

Title/Subject	User
Various descriptive documents	John Hopkins University, Applied Physics Lab Warren J. Boord (301) 953-6284
TEAM - User, reference, and development manuals	Air Force Information Warfare Center (AFWIC/SAC) Jim Washington (210) 977-2391
Changes to TRAP code "TRAP 3.0 Real Seeker Gimbal Angle Correction", 14 May 93	NAWCWPNS Mark Lawson (760) 939-8233
Documented pitfalls/problems of using TRAP for validation/verification of FAAC simulations.	FAAC, Inc. Don Storey (313) 761-5836
Tactical Aircrew Combat Training System/Air Combat Training System (TACTS/ACTS) (TRAP used as reference in some V&V documents)	First Ann Arbor Corp. (FAAC), Inc. NAWCADWAR Don Storey (313) 761-5836
F-22 EW; CF-18 Study; Co-Operative IRCM	Lockheed Sanders Cmd Division Paul Egbert (603) 885-8268
F-22 IRCM	Lockheed Sanders Tom Korzeniowski (603) 885-5600
TIER II; JAST	Northrop/Grumman/NATDC Michael J. Petka (310) 948-7868
"TRAP V.3.0 Seeker Models", "TRAP V.3.0 Guidance, Control, and Autopilot Modeling", 12 September 1990 (Modified source code)	Science Engineering Associates, Inc. and General Research Corporation
Classified Special Access Documents	Aeronautical Systems Command (ASC/VJE) Jim Gray (513) 255-4272

4.3 IMPLICATIONS FOR MODEL USE

NAIC is the intelligence authority for air-to-air threats. TRAP is updated constantly to reflect the latest intelligence on the systems modeled. Much of the documentation generated by NAIC on internal V&V of TRAP is not readily available to the user community due to security restrictions. In spite of the lack of documentation, the extensive use of the simulation by the intelligence community lends credibility to its accuracy to simulate threat weapon systems of interest, and a potential user should consider this acceptance when questioning whether to apply the simulation to a task.

TRAP has been employed by a wide spectrum of users in a wide variety of efforts, including assessment of threat capabilities, tactics development, procurement decisions, weapon system design, training system design, and combat training. TRAP has also been used to generate data for the "validation" of other models. TRAP is in the SURVIAC library of models, and is accepted by the JTCG/AS as the standard AAM model. In addition, TRAP was accepted by the OT&E community as the standard air-to-air missile flyout simulation for use in EC Hardware-in the Loop facilities, constructive simulations, and on OARs. Efforts are currently underway to convert the model to support this real-time requirement.

As was the case in the intelligence community, the user community, in general, does not offer exchange of V&V documentation. This is most likely due to the proprietary nature of their applications. However, acceptance of the model by such a large number of government and industrial users lends some credibility to its performance.